Partial Translation
of Japanese Laid-Open Patent Application No. 2002-008942

[0025]

A description is given, with reference to FIG. 2 through FIG. 4, of a fabrication method for a capacitor device according to a first embodiment of the present invention. FIGS. 2(a) through 2(d), FIGS. 3(a) through 3(c) and FIGS. 4(a) and 4(b) are cross-sectional views illustrating a fabrication method for a capacitor device according to the first embodiment of the present invention. As shown in FIG. 2(a), first, a resist pattern (not illustrated) is formed in a predefined area on a silicon substrate 10 having the depth of 300 μm, and through holes 12a, 12b and 12c, each of which has the diameter B of 60 μm and the pitch A of 150 μm, are formed through dry etching using CF_4, for example. Then, a support body 11 of the capacitor is formed by filling a conductive material in the through holes 12a, 12b and 12c in accordance with CVD method.

[0026]

In FIG. 2(a), five through holes are formed. Two both end through holes are collectively referred to as first through holes 12a. Two through holes located at the inner side of the first through holes 12a are collectively referred to as second through holes 12b. The remaining one located at the center is referred to as a through hole 12c to mutually connect a signal line between the semiconductor device and the circuit substrate. Next, as shown in FIG. 2(b), a Ti (Titanium) film 14a having a thickness of about 0.1 μm and a Pt (Platinum) film 14b having a thickness of about 0.2 μm are formed in that order on the silicon substrate 10 through sputtering. Subsequently, a resist film (not illustrated) is patterned through photolithography so as to form apertures. Then, by using the resist film as a mask, the Pt film 14b and the Ti film 14a are etched to form a lower electrode 14 as a first electrode.

[0027]

Next, as shown in FIG. 2(c), a $BaSrTiO_3$ (Barium

Strontium Titanium oxide film, hereinafter which is referred to as BST) film, which is a high dielectric material, is formed through sputtering. Then, after forming of a resist film (not illustrated) on the BST film, the resist film is patterned through photolithography so as to form apertures. After that, by using the resist film as a mask, the BST is etched by using buffered hydrofluoric acid (NH_4F:HF=6:1) as an etching liquid so as to form a high dielectric film 16 as a capacitor insulation film. At this time, apertures are formed on a portion of the lower electrode 14, the second through holes 12b and the through hole 12c of a signal line.

[0028]

Next, as shown in FIG. 2(d), after forming of a Pt film having a thickness of about 0.2 μm through sputtering, a resist film is formed on the Pt film. Subsequently, the resist film (not illustrated) is patterned through photolithography to form apertures, and then by using this resist film as a mask, the Pt film is etched to form an upper electrode (second electrode) 18 connected to conductors of the second through holes 12b. Thereby, a capacitor is formed by sandwiching the high dielectric layer 16, which is formed as a BST film, between the lower electrode 14 and the upper electrode 18.

[0029]

Also, at the same time, a conductive film connected to the lower electrode 14 via the aperture of the high dielectric film 16 and a conductive film connected to a conductor in a through hole of a signal line are formed. Then, as shown in FIG. 3(a), a photosensitive polyimide film is coated and patterned to form apertures. The apertures are formed on the upper electrode 18, the conductive film connected to the lower electrode 14 via the aperture of the high dielectric film 16 and the conductive film connected to the conductor in the through hole 12c of a signal line. The remaining polyimide film becomes a protective film 20.

[0030]

Then, a Cr (Chromium) film, a Ni (Nickel) film and

an Au (gold) film are sequentially formed in that order on the protective film 20. After forming of a resist film (not illustrated), the resist film is patterned through photolithography to form apertures. After that, by using this resist film as a mask, the Au film, the Ni film and the Cr film are etched to form five electrode pads 21a, 21b and 21c. Among these five electrode pads 21a, 21b and 21c, two both end pads are first connection electrodes 21a connected to conductors in the first through holes 12a. The two pads located at the inner side of the end pads are third connection electrodes 21b connected to conductors in the second through holes 12b. The remaining one pad located at the center is a connection electrode 21c of a signal line.

[0031]

Next, as shown in FIG. 3(c), after a photosensitive polyimide film is coated on the back surface of the support substrate 11, a protective film 22 having apertures in areas of the through holes 12a, 12b and 12c is formed by exposing and developing the polyimide film. Then, a Cr film, a Ni film and an Au film are sequentially formed in that order on the protective film 22 on the back surface of the support substrate 11. Subsequently, after forming of a resist film (not illustrated), the resist film is patterned through photolithography to form apertures. After that, by using this resist film as a mask, the Au film, the Ni film and the Cr film are etched to form five electrode pads 24a, 24b and 24c connected to conductors of the through holes 12a, 12b and 12c.

[0032]

Next, as shown in FIGS. 4(a) and 4(b), a solder formed of Pb (Lead)-5wt%Sn (Tin) is deposited via a metal mask on the electrode pads 24a, 24b and 24c to form a solder film 26. Then, a flux is coated to prevent oxidation of the surface of the solder film 26, and five bump electrodes 28a, 28b and 28c, which are used to connect to the circuit substrate, are formed by heating and melting the solder film 26 at 350 ℃. Among the five bump electrodes 28a, 28b and 28c on the back surface,

two both end electrodes are second connection electrodes 28a connected to conductors in the first through holes 12a. The two electrodes located at the inner side of the both end electrodes 28a are fourth connection electrodes 28b connected to conductors in the second through holes 12b. The remaining one electrode at the center is a connection electrode 28c of a signal line.